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Description of Proposed Alternatives

North Delta Flood Control and
Ecosystem Restoration Project

Levees and North Delta Branch
Bay-Delta Office
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**not yet completed*

Document Purpose

This document details the North Delta Flood Control and Ecosystem Restoration Project options that form project alternatives to be taken forward for detailed impact analysis in the project EIR. This is a challenging project to achieve well-integrated ecosystem restoration and flood control within a complex system and provide additional enhancements such as recreation and conveyance benefits to the extent possible. The project area portrays the primary study area for planning flood control and ecosystem restoration improvements and the solution area highlights the areas where flood control and ecosystem restoration improvements may be implemented (Refer to Figure 1).

Although refinement is still necessary within the proposed options, preliminary analysis such as hydraulic modeling, have indicated that these general concepts hold the greatest promise for achieving project goals. All proposed options include several common components including opening McCormack-Williamson Tract to flood flows. These common components are included with each pairing of flood control and ecosystem restoration options to form project alternatives. Figure 2 summarizes the relationship between components, options, and alternatives.

Components are various actions and measures to achieve project goals that have been developed and refined through technical brainstorming sessions, public and agency scoping input, hydraulic modeling, and stakeholder participation. While additional refinement of these components is ongoing, the components have been categorized into three basic groupings. The common components include actions and measures to be implemented for all alternatives, except the no project alternative. The most significant common component is the opening of McCormack-Williamson Tract to flood and/or tidal flows. This action and the other common components are combined with ecosystem restoration options that compliment opening up McCormack-Williamson Tract and the various potential options to address the downstream flood capacity needs from opening up McCormack-Williamson Tract. Four variations of flood control components comprise the flood control options to be evaluated. Three ecosystem restoration options are to be analyzed, each including restoration components that are varying in habitat type. Our analysis has shown that the ecosystem restoration options do not appreciably affect the performance of flood control options and vice versa; therefore these options can be mixed interchangeably. The inclusion of a flood control option, ecosystem restoration option and common components comprise a general alternative.

There is much uncertainty regarding the viability of dredging due to current regulatory conditions. Therefore, each alternative is presented with a scenario that precludes dredging (and relies solely on other components such as detention basins to provide required downstream capacity) and a scenario that includes dredging. The scenarios that include dredging allow more flexibility in project phasing as upstream components can be implemented incrementally along with incremental dredging to address the increased downstream capacity necessitated by upstream changes. The table below illustrates the naming convention for the flood control options to be taken through impact analysis. Similarly, the ecosystem restoration components considered for this project are grouped into three ecosystem restoration options, and are detailed in this document.

Table 1: Naming Convention of Flood Control Options

DESCRIPTION OF FLOOD CONTROL OPTIONS	NAMING CONVENTION	
	No Dredging	Dredging
North Staten Island Detention	1	1D
West Staten Island Detention	2	2D
East Staten Island Detention	3	3D
Dredging and Levee Raising	N/A	4

Throughout this report, the source of existing elevation data is from the North Delta Study geodatabase on the DWR GIS server dated 1995 (revised in 2000). All elevations are related to the National Geodetic Vertical Datum of 1929 (NGVD29) in units of feet, unless specified otherwise. The data is located in the p_delta_public database connection under jdudas.elevation, and the feature class is named “contours_north_delta_study”. The contours were generated from photogrammetry data. Proposed changes to the existing topography through levee degradation, levee construction, ecosystem restoration components and weir construction are related to Mean Sea Level Datum, which can be equated to the National Geodetic Vertical Datum of 1929.

Proposed Alternatives for EIR EIS Impact Analysis

The following subsections specify the components of each flood control and ecosystem restoration option selected for detailed impact analysis. The purpose is to provide adequate information so that an accurate impact analysis of the selected options can be performed. Since this project is still in the planning phase, some components of the options are not yet clearly defined. Future reports will detail components that have not fully been developed.

Common Components

Some components considered for the project are to be combined with each of the options that are to be taken through impact analysis. The purpose of this subsection is to describe the components. The following list describes all common components and is followed by a detailed description of each:

- Degradation and armoring of McCormack-Williamson Tract east levee
- Degradation (and armoring as needed) of southwest levee according to ecosystem restoration option
- Wildlife-friendly levees
- Protective levee for KCRA-3 TV tower and facilities
- Alternate road access to KCRA-3 TV tower and facilities

Extensive hydraulic modeling shows the necessity to degrade a portion of the east and southwest levees on M-W Tract to achieve desired flood control benefits in the upper portion of the project area, which is measured by stage reductions at Benson’s Ferry. Since the North Delta study area is limited by channel capacity flow, flows overtop the east levee on M-W Tract, which is legally restricted in height and the levee fails during large storm

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events. M-W Tract fills and causes the southwest levee to breach catastrophically, causing a surge effect downstream which displaces boats and precipitates further levee failures, etc. Lowering the elevation of the M-W Tract levees would allow flow to move through the system in a controlled manner, eliminating this “surge” effect. This action would convey flood flows more efficiently, potentially causing downstream stage impacts. Each flood control option addresses potential downstream impacts with components such as detention basins, setback levees, dredging and raising existing levees.

The east levee of McCormack-Williamson Tract would be lowered to allow flood flows onto the tract. 3000’ of the east levee would be degraded to an elevation of 8.5’ (from an existing elevation of 17’-18’). The McCormack-Williamson Tract southwest levee would be degraded along the entire length of Dead Horse Cut from an existing elevation of 15’ msl to an elevation of -2.5’ or 5.5’ msl, depending on which ecosystem restoration option is selected, to complete flood conveyance functionality. The interior of all McCormack-Williamson Tract levees (unless inconsistent with one of the proposed ecosystem restoration options described in a subsequent section) would be low-slope (5:1) wildlife-friendly levees. These levees would protect the McCormack-Williamson Tract from erosion when the Tract is flooded.

All options include degrading the east and southwest levees on M-W Tract, allowing the Tract to serve as a floodway during high flows. The height of the southwest levee varies depending on whether tidal action is desired for the ecosystem restoration option. Preliminary modeling showed minimal sensitivity of flood performance to variation of the southwest levee height. The Nature Conservancy (current landowner of M-W Tract) has an existing lease with Hearst-Argyle Television Co (KCRA-channel 3) on a parcel in the northwest portion of the Tract that requires all alternatives to maintain the current level of flood protection on the leased property and road access.

Maintaining the current level of flood protection on the leased property requires a protective levee around a portion or all of the leased property (Refer to Figure 3 for protective levee alignments). The levee must protect the tower and the building, but it is still unclear whether the levee must surround the guy wires and anchors as well. Department of Water Resources (DWR) is in the process of analyzing whether inundating M-W Tract more frequently, and in turn, inundating the guy anchors and possibly wires more frequently has an adverse impact on these components of the transmission tower structure. To complete this analysis, we must determine the frequency of inundation currently and for all proposed changes to M-W Tract levees, as well as the duration of inundation and the water surface elevation in the vicinity of the guy wires and anchors during periods of inundation. The length of the levee will range from 2250’-4000’, depending on the outcome of the structural analysis. The elevation of the levee is to be high enough to prevent water from inundating the structures more frequently than the current level of protection (TBD).

To maintain access to the KCRA TV tower and facilities on the leased property, M-W Tract east levee would have to be armored. This would provide alternate access to the leased property, as illustrated in Figure 4. Based on negotiations between KCRA-channel 3 and The Nature Conservancy (TNC), it is our understanding that the modification to the east levee described above is acceptable as alternate road access. Maintaining an elevation of 8.5’ on the east levee would assure no additional flooding occurs, with respect to the current

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road access flood risk. This is based on the lowest elevation of the current road access, which is 8.5' along the Mokelumne River levee (Refer to Figure 5).

Dead Horse Island is under consideration for flood control and/or ecosystem restoration benefits and further modeling will determine the benefits of this island as a component of the alternatives. The existing elevation of the east levee on Dead Horse Island is 15' and the west levee elevation slopes from 13'-15'. A possible flood control enhancement would include degrading the east and west levees to provide better conveyance through the system. If it is determined that flood control or ecosystem restoration cannot be economically achieved with this enhancement, the existing Dead Horse levee configuration will remain. However, Dead Horse levee slope protection will be enhanced to address the increased frequency of flooding through M-W Tract.

Flood Control Options

Flood Control Option 1- North Staten Island Detention

Flood Control Option 1 includes all common components described above and a detention basin on the northern end of Staten Island. Figure 6 illustrates the components of this alternative. Degrading M-W Tract levees would provide better conveyance in the upper portion of the system and the detention basin is the flood control measure for addressing potential downstream impacts. Table 2 lists all components of option 1.

Table 2: Flood Control Option 1 Components

	COMPONENT DESCRIPTION
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	Millers Ferry Bridge replacement
5	New Hope Bridge replacement
6	Cross levee for detention on Staten Island
7	Pumps for detention basin waters
8	Inlet weir on Staten Island
9	Protective levee for home and barn on Staten Island
10	Protective levee for grain dryer on Staten Island
11	Breach levee on northern tip of Staten Island
12	Internal detention levee(s) on Staten Island
13	Degrade Dead Horse Island east and southwest levees *

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flows would be conveyed from M-W Tract (and possibly Dead Horse Island) to Staten Island by degrading the northern levee on Staten Island from an existing elevation of 15' to a lower elevation (TBD through iterative modeling). A weir would be constructed along the existing county road to allow flood flows to enter the detention basin in high flow events. Although the weir height and corresponding flow frequency must be refined, the

detainment area will not capture flow from events less than the 10 year flood event. As well, due to political constraints, the basin will not be able to detain flows greater than or equal to the FEMA 100 year flood event. The detention basin capacity will be designed based on the 1997 flood event. The required acreage for the detention basin has not yet been determined. Additional modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. A cross levee would be designed to detain peak flood flows for the 1997 flood. Additional internal levees within the larger detention area could detain peak flows during lesser events (e.g. 10, 25 and 50 year events) within a smaller portion of the island. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump any water that cannot be gravity drained out of the detention basin after the flood event.

The county road would have to be raised to accommodate the construction of weir that will follow the same alignment as the roadway. It is also possible that the road would be realigned to minimize the length of raised roadway/weir that will be required. (The Department of Water Resources has been consulting with San Joaquin County Engineers to define modifications to the existing roadway.) Miller Ferry Bridge and New Hope Bridge replacements may be necessary to allow for construction of weir and to accommodate a potential realignment of the county road. Protective levees around the grain dryer, home and barn on Staten are necessary for this alternative to protect existing infrastructure that is vital to the agricultural operation on Staten Island, unless another option becomes available, such as relocation.

Flood Control Option 1D – North Staten Island Detention and Dredging

All components described in flood control option 1 apply to 1D, with the addition of the dredging component. The benefits of including dredging as a flood control component are that this alternative has the potential to be phased.

It is proposed that flood control option 1D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 3). Viability of proposed project phasing needs to be verified through modeling as each phase must adequately address hydraulic impacts. Components of each phase are specified in Table 3 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred, thus reducing channel capacity. The dredged material is to be used for levee construction and ecosystem restoration. The locations, quantities, and phasing of dredging are detailed in Appendix A. Dredging proposed during the first phase of each alternative would include a portion of the Mokelumne, Snodgrass Slough and Dead Horse Cut, totaling approximately 31,000 feet of river channel and 4,500,000 cubic yards of material. Studies performed during this process will determine whether dredging will occur during phase 3 of the project. Given that dredging in the first phase of the project goes as planned, the third phase dredging component includes the Mokelumne River above the demonstration project and the South Fork Mokelumne River below the demonstration project. Approximately

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42,000 feet of river channel and 4,570,000 cubic yards of material are to be dredged during the final phase of the North Delta Flood Control and Ecosystem Restoration Project.

Table 3: Flood Control Option 1D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 Dredging	•		
2	KCRA-3 protective levee	•		
3	Degrade M-W Tract east and southwest levees	•		
4	Raise/realign county road on Staten Island		•	
5	Millers Ferry Bridge replacement		•	
6	New Hope Bridge replacement		•	
7	Cross levee for detention on Staten Island		•	
8	Pumps for detention basin waters		•	
9	Inlet weir on Staten Island		•	
10	Protect or relocate home and barn on Staten Island*		•	
11	Protect or replace grain dryer on Staten Island		•	
12	Breach levee on northern tip of Staten Island		•	
13	Phase 3 Dredging			•
14	Internal detention levee(s) on Staten Island			•
15	Degrade Dead Horse Island east and southwest levees*			•

*Modeling and analysis is necessary to determine whether this component will be included.

Flood Control Option 2 – West Staten Island Detention

Flood control option 2 improves flood control with a setback levee to increase capacity on the north fork and detention basin off the North Fork Mokelumne River to detain peak flood flows (Figure 7 illustrates option 2 components and Table 4 lists all components of the option). The setback levee and detention area on the North Fork Mokelumne River are to mitigate for downstream impacts due to degrading M-W Tract levees.

The setback levee begins at the northern end of Staten Island and runs parallel to the North Fork until the River Field Gas Line, where an inlet weir would be constructed to divert flows to a detention basin that would be located on the northwest side of Staten Island. The proposed setback distance is 500 feet, but refined modeling of this alternative may show that a shorter setback distance will provide sufficient capacity. The detention basin capacity would be designed based on the 1997 flood event. The required acreage for the detention basin has not yet been determined. Additional modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump any water that cannot be gravity drained out of the detention basin after the flood event.

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The proposed setback levee on the North Fork would most likely require the county road to be raised and/or realigned. Replacement of Millers Ferry Bridge would be necessary if modifications are made to the existing roadway. A protective levee around the home and barn on Staten are necessary for this alternative to protect existing infrastructure on Staten Island, unless another option becomes available, such as relocation.

Table 4: Flood Control Option 2 Components

COMPONENT DESCRIPTION	
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	Millers Ferry Bridge replacement
5	Protective levee for home and barn on Staten Island
6	Setback levee on North Fork Mokelumne River
7	Detention basin off the North Fork Mokelumne River
8	Pumps for detention basin waters
9	Inlet weir to detention basin
10	Degrade Dead Horse Island east and southwest levees*

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flood Control Option 2D – West Staten Island Detention and Dredging

Flood control option 2D is comprised of all components specified in option 2 and dredging. The benefits of including dredging as a flood control component are that the alternative has the potential to be phased.

It is proposed that option 2D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 5). Viability of proposed project phasing needs to be verified through modeling as each phase must adequately address hydraulic impacts. Components of each phase are specified in Table 5 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred. Dredging details are identical to those in alternative 1D and an additional source of dredge information is in Appendix A.

Table 5: Flood Control Option 2D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 dredging	•		
2	KCRA-3 protective levee	•		
3	Degrade M-W Tract east and southwest levees	•		
4	Raise/realign county road on Staten Island		•	
5	Millers Ferry Bridge replacement		•	
6	Protective levee for home and barn on Staten Island		•	
7	Setback levee on North Fork Mokelumne River		•	
8	Detention basin off the North Fork Mokelumne River		•	
9	Pumps for detention basin waters		•	
10	Inlet weir to detention basin		•	
11	Phase 3 dredging			•
12	Degrade Dead Horse Island east and southwest levees*			•

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flood Control Option 3 – East Staten Island Detention

Flood control option 3 includes a setback levee and detention basin on the South Fork Mokelumne River as well as all common components described (Refer to Table 6 for a list of components). This option is illustrated in Figure 8. The setback levees on the South Fork of the Mokelumne River begin at the northern end of Staten and run parallel to the river at a distance TDB from the channel until the middle of New Hope Tract, where an inlet weir would be constructed to divert flows to a detention basin. The detention basin is located on the northeast portion of Staten to pull off flows from the river.

The required acreage for the detention basin has not yet been determined. Additional modeling will be done to size the basin for the 1997 event while minimizing required acreage and frequency of inundation. Once all the details of the detention basin size, weir elevation and length have been determined, an appendix in addition to this report will detail the detention basin configuration. In the event that the basin fills, permanent or portable pumps would operate to pump the water out of the detention basin after the flood event.

The county road on the northern tip of Staten Island would have to be relocated and/or raised to accommodate for the setback levee. New Hope Bridge replacement is specified in this alternative to allow the setback levee and changes in the county road. Also, replacement of the existing bridge with a higher bridge would alleviate a historic constriction point on the South Fork Mokelumne River. A protective levee around the grain dryer on Staten is necessary for this alternative to protect existing infrastructure on Staten Island from water in the South Fork detention basin, unless another option becomes available, such as relocation.

Table 6: Flood Control Option 3 Components

	COMPONENT DESCRIPTION
1	KCRA-3 protective levee
2	Degrade M-W Tract east and southwest levees
3	Raise/realign county road on Staten Island
4	New Hope Bridge replacement
5	Protective levee for grain dryer on Staten Island
6	Setback levee on South Fork Mokelumne River
7	Detention basin off the South Fork Mokelumne River
8	Pumps for detention basin waters
9	Inlet weir to detention basin
10	Degrade Dead Horse Island east and southwest levees*

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flood Control Option 3D

Alternative 3D is comprised of all components specified in option 3 and dredging. Detail on the benefits of dredging is explained in option 1D.

It is proposed that alternative 3D be implemented through phasing with a maximum of three project phases prior to completion (Refer to Table 7). Viability of proposed project phasing needs to be verified through modeling as each phase must adequately address hydraulic impacts. Components of each phase are specified in Table 7 in the necessary order of completion.

Dredging would increase channel capacity in locations where sedimentation has occurred. Dredging details are identical to those in option 1D and an additional source of dredge information is in Appendix A.

Table 7: Flood Control Option 3D Components and Project Phasing

	COMPONENT DESCRIPTION	PROJECT PHASE		
		1	2	3
1	Phase 1 dredging	•		
2	KCRA-3 protective levee	•		
3	Degrade M-W Tract east and southwest levees	•		
4	Raise/realign county road on Staten Island		•	
5	New Hope Bridge replacement		•	
6	Protective levee for grain dryer on Staten Island		•	
7	Setback levee on South Fork Mokelumne River		•	
8	Detention basin off the South Fork Mokelumne River		•	
9	Pumps for detention basin waters		•	
10	Inlet weir to detention basin		•	
11	Phase 3 dredging			•
12	Degrade Dead Horse Island east and southwest levees*			•

*Modeling and analysis is necessary to determine whether this component will be included in the alternative.

Flood Control Option 4- Dredging and Levee Raising

This option consists of all components in the Common Components subsection, the maximum dredge bounds detailed in Appendix A (dredging would not be phased in the alternative) and raising downstream levees to mitigate for impacts not addressed by dredging (Refer to Figure 9). If modeling shows that dredging alone would not address downstream impacts, levee raising would be included in this option to the extent that it is not cost prohibitive. The fill material estimates associated with levee raising will be calculated once additional models are performed to determine the required levee raise to offset downstream stage impacts. Table 8 lists alternative 4 components.

Table 8: Flood Control Option 4 Components

	COMPONENT DESCRIPTION
1	KCRA-3 protective levee
2	Dredging (maximum dredge bounds)
3	Levee raising
4	Degrade M-W Tract east and southwest levees
5	Setback levees on North & South Fork Mokelumne River*
6	Degrade Dead Horse Island east and southwest levees*

*These components still have to be evaluated further

Ecosystem Restoration Options

Ecosystem Restoration Option 1 – Fluvial Maximum (Minimum Control)

The main objective of this alternative is to promote sedimentation. Would make MWT a riverine and floodplain system (not just floodplain). Compatible with wetlands in the south. Primarily sediment would come through fluvial processes though tidal processes might contribute some sediment as well (especially when DCC open). MWT represents the transition from wetlands to riverine habitat in the Delta. The east levee would be raised with an inflatable dam that could be deflated during infrequent (>1:50 year events, for example) to enhance conveyance through MWT. To promote the riverine processes, a starter channel would be cut off of the Mokelumne River into MWT. A secondary channel should then form within MWT. To promote tidal processes, the southwest levee would be degraded to land surface elevation, -2.5' msl. This would allow the formation of tidal channels at appropriate elevations, near sea level. Benefits of sedimentation throughout the MWT include increasing topographic diversity on MWT and increasing elevation over time (Refer to Figure 10).

Ecosystem Restoration Option 2 – Fish Ecological Maximum (Maximum Control)

The main objectives of this alternative are to benefit floodplain spawning fish and to discourage exotics. By lowering the east MWT levee to 8.5' msl, the MWT would flood every year during the January to May period. MWT would drain through the use of nekton gates and would be dry during the summer, thereby reducing exotic aquatic species issues. Nekton gates, placed in the lowest elevations in the south, would allow some tidal action during the winter-spring (January-May). These gates would partially fill during incoming tide, and fully drain during outgoing tide. The southwest MWT levee would be lowered to 5.5' msl to enhance flow-through during flood events (Refer to Figure 11).

Ecosystem Restoration Option 3 – Hybrid Floodplain/Subsidence Reversal

This alternative is similar to II. in providing floodplain habitat for fish, but also provides a subsidence reversal demonstration project area in the south. The subsidence reversal demonstration project area would be created by building a cross-levee at 5.5' msl to isolate the southern tip of MWT. The southwest levee would be degraded to 5.5' msl to enhance flow-through during flooding events. The subsidence reversal demonstration project would be effectively isolated from the channels and the rest of MWT except for in flood events. Water would be siphoned onto the subsidence reversal demonstration project area to grow tules and enhance accretion rates; thereby building up elevation in this area. Alternative subsidence reversal techniques, such as thin-layer sediment addition could be part of this demonstration project. During flood events the tule marsh may also enhance sedimentation in this area. The subsidence reversal project area could also serve as a rearing area for Sacramento perch. Existing agricultural pumps would be used to pump the area after floods (Refer to Figure 12).

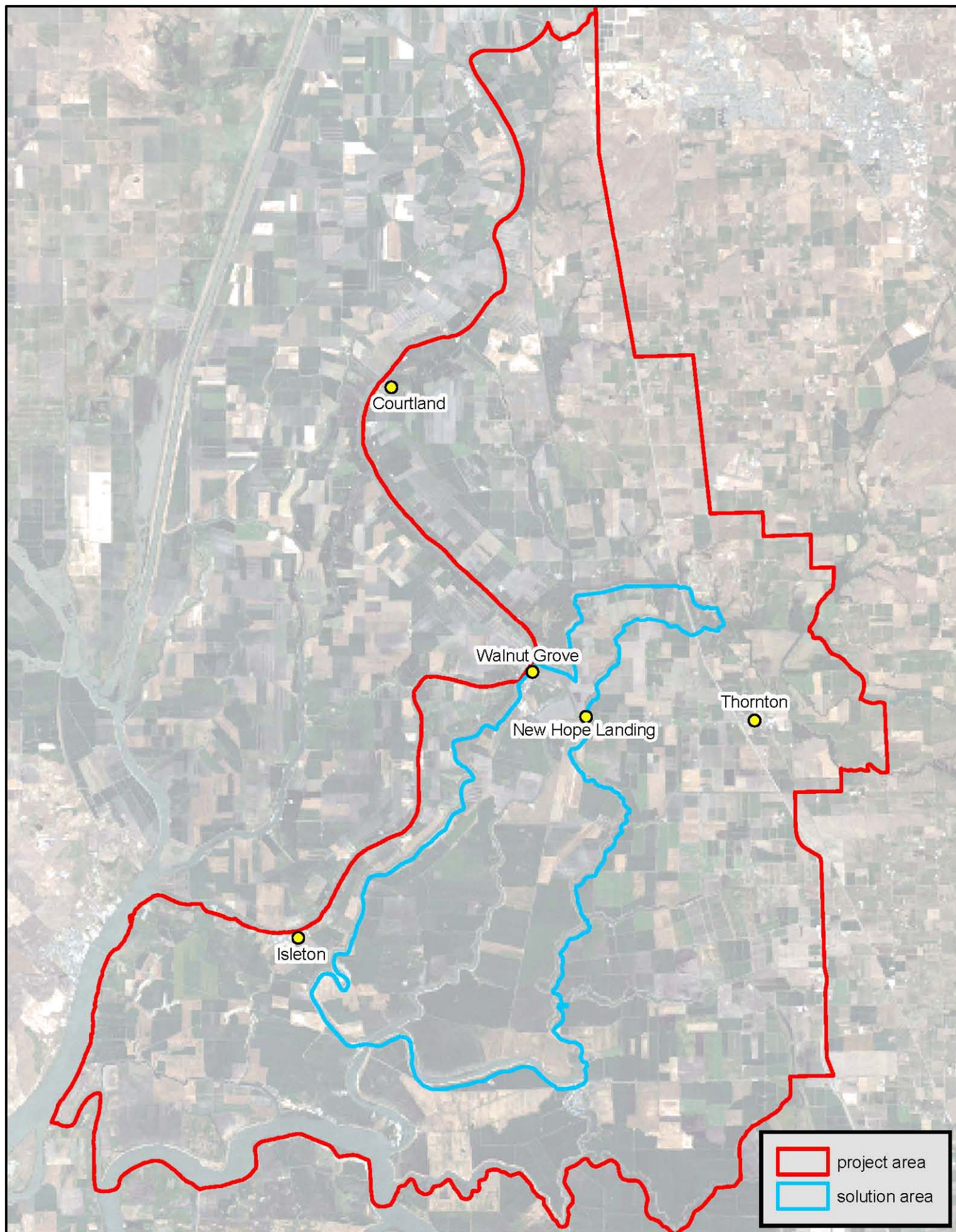


Figure 1: North Delta Flood Control and Ecosystem Restoration Project and Solution Area

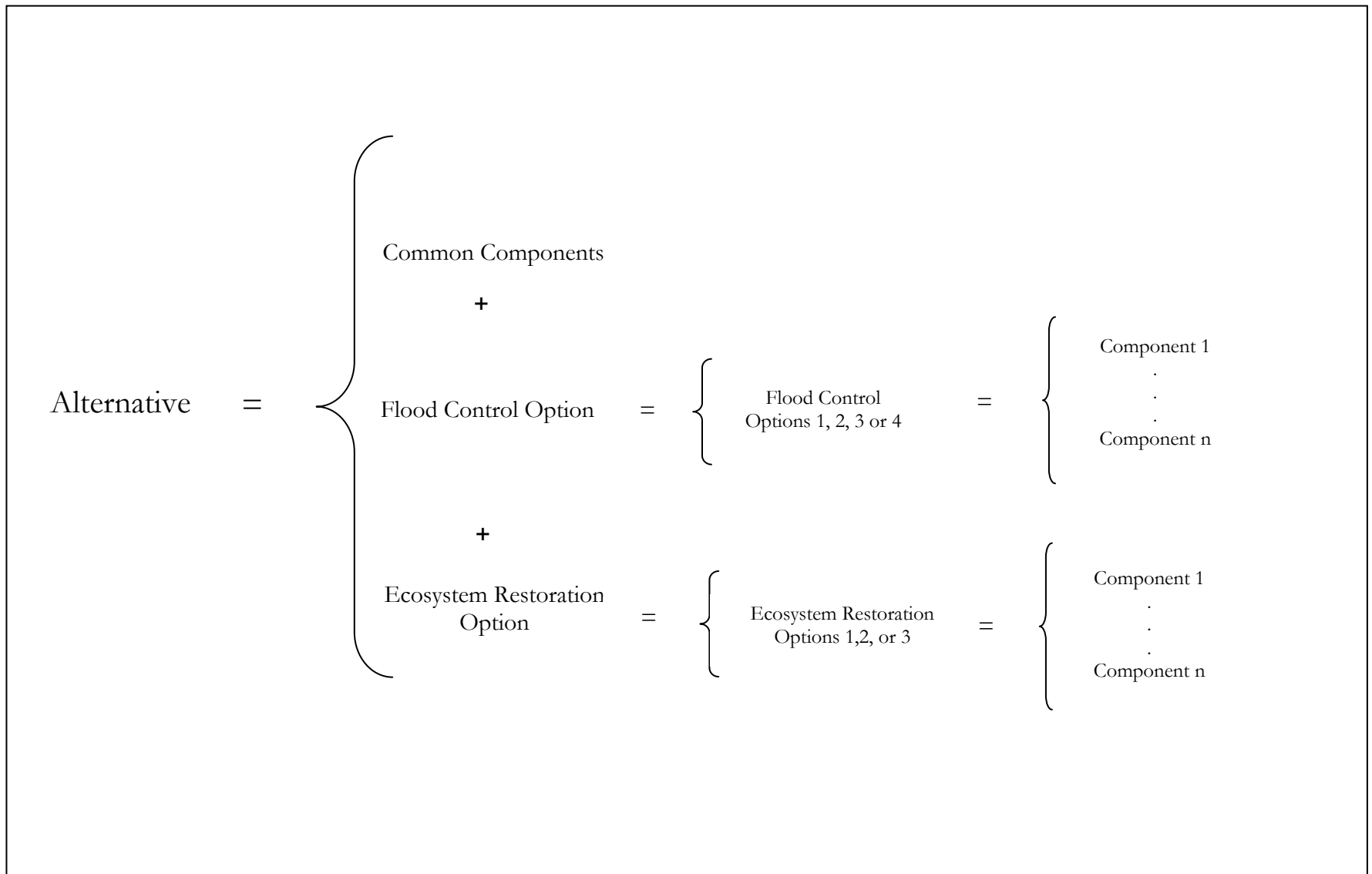


Figure 2: Relationship between Alternatives, Options and Components

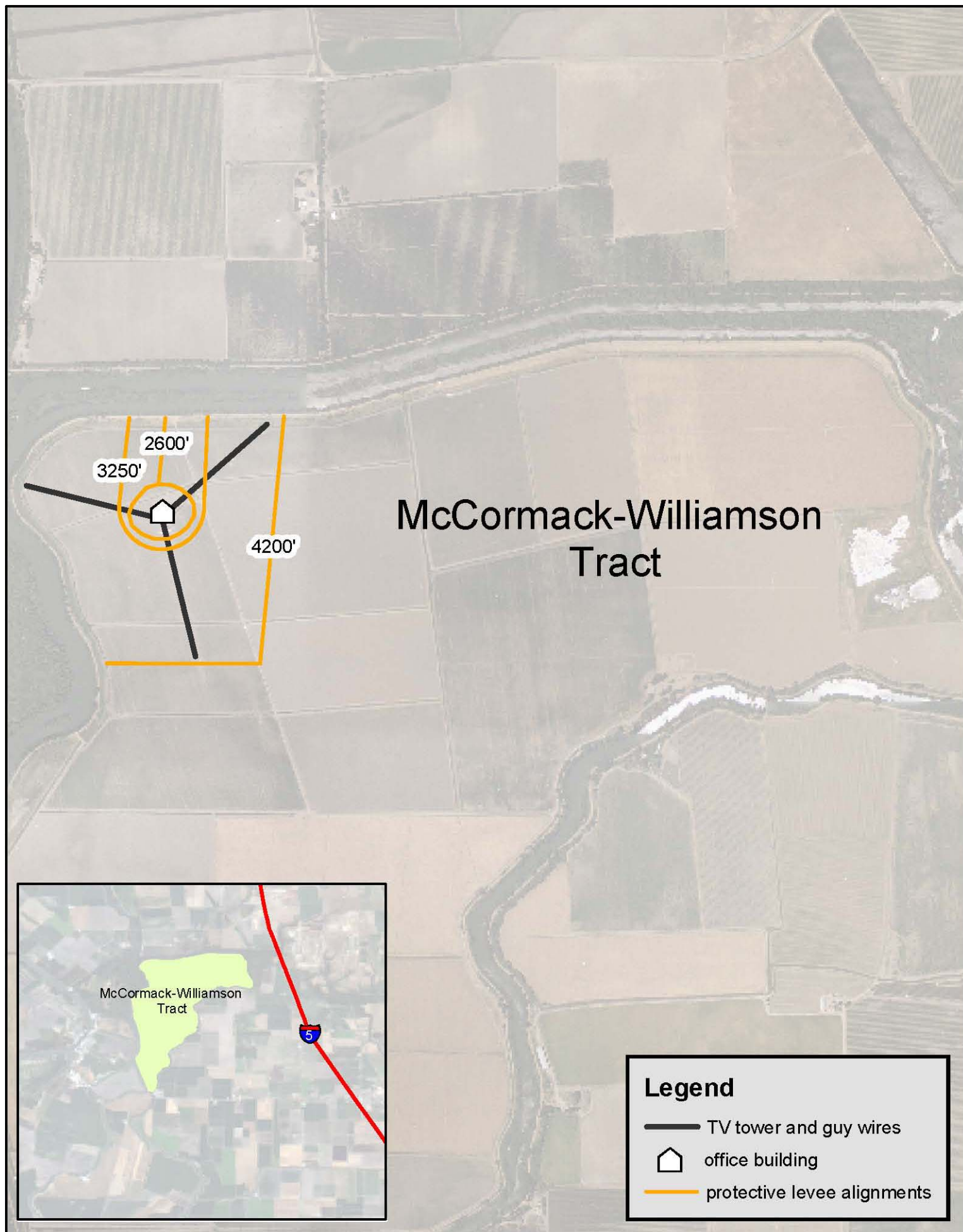


Figure 3: KCRA-3 Property Protective Levee Alignments

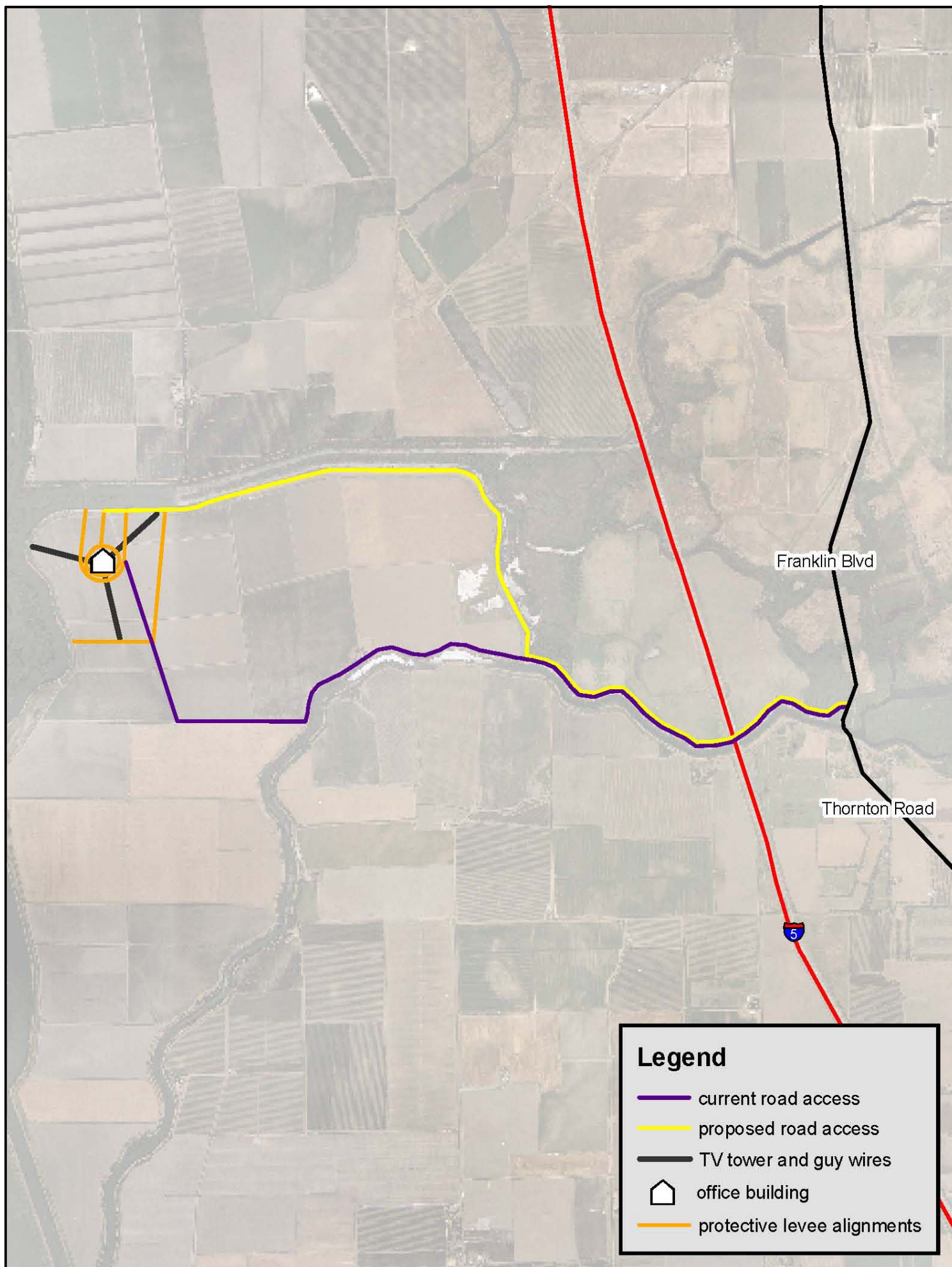


Figure 4: Current and Proposed KCRA-3 Road Access

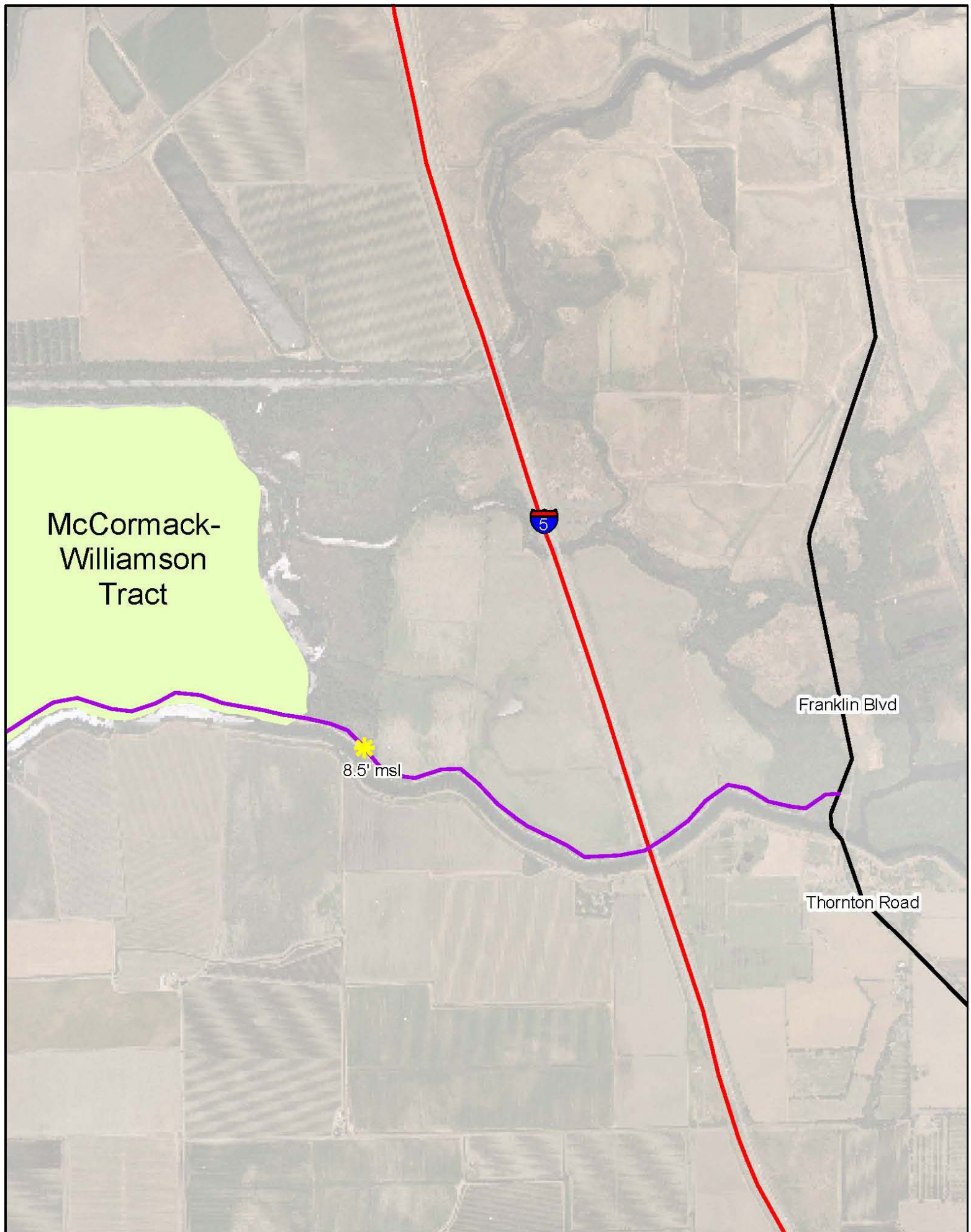


Figure 5: Location of Lowest Levee Elevation along Mokelumne River Levee

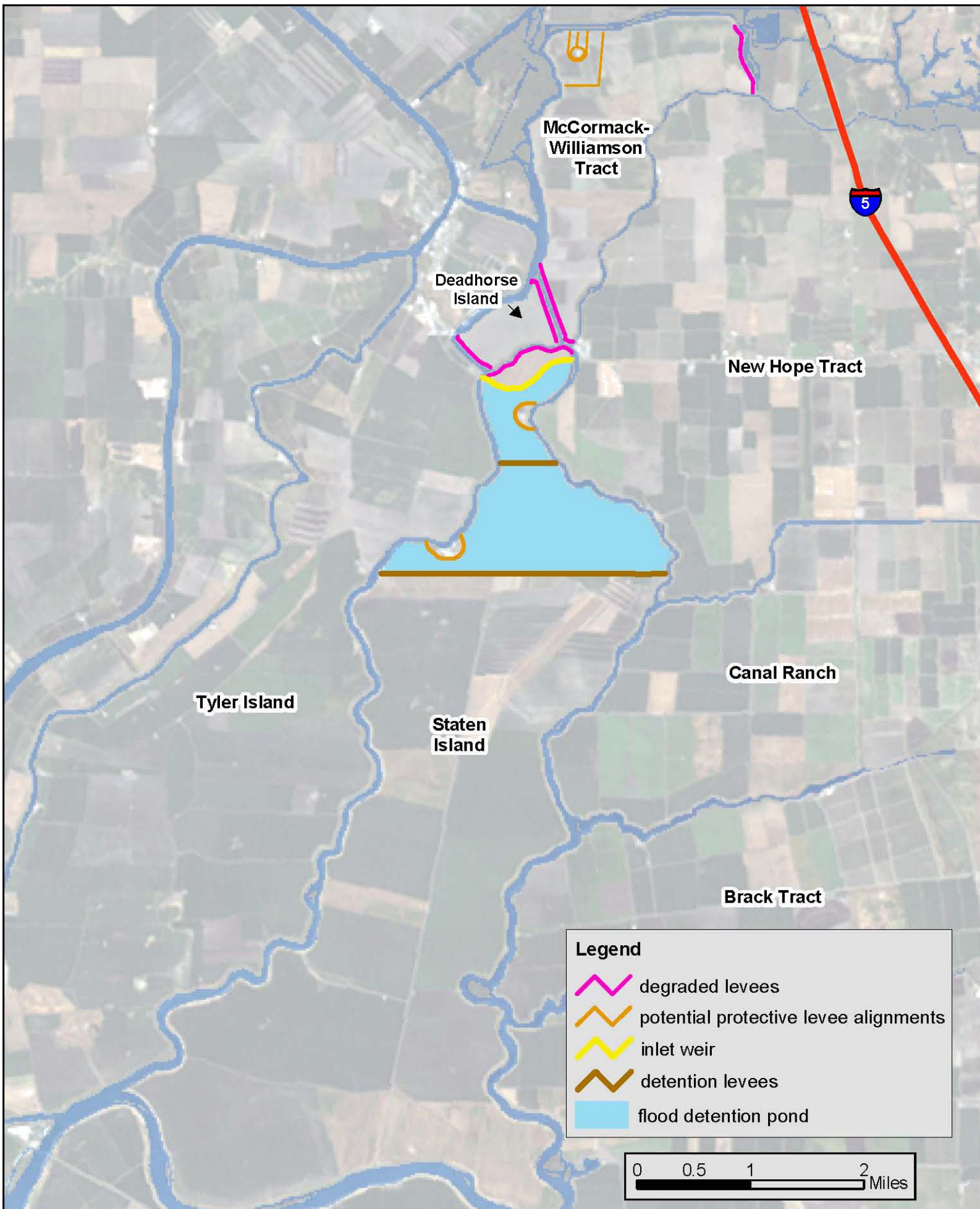


Figure 6: Flood Control Option 1 – North Staten Island Detention

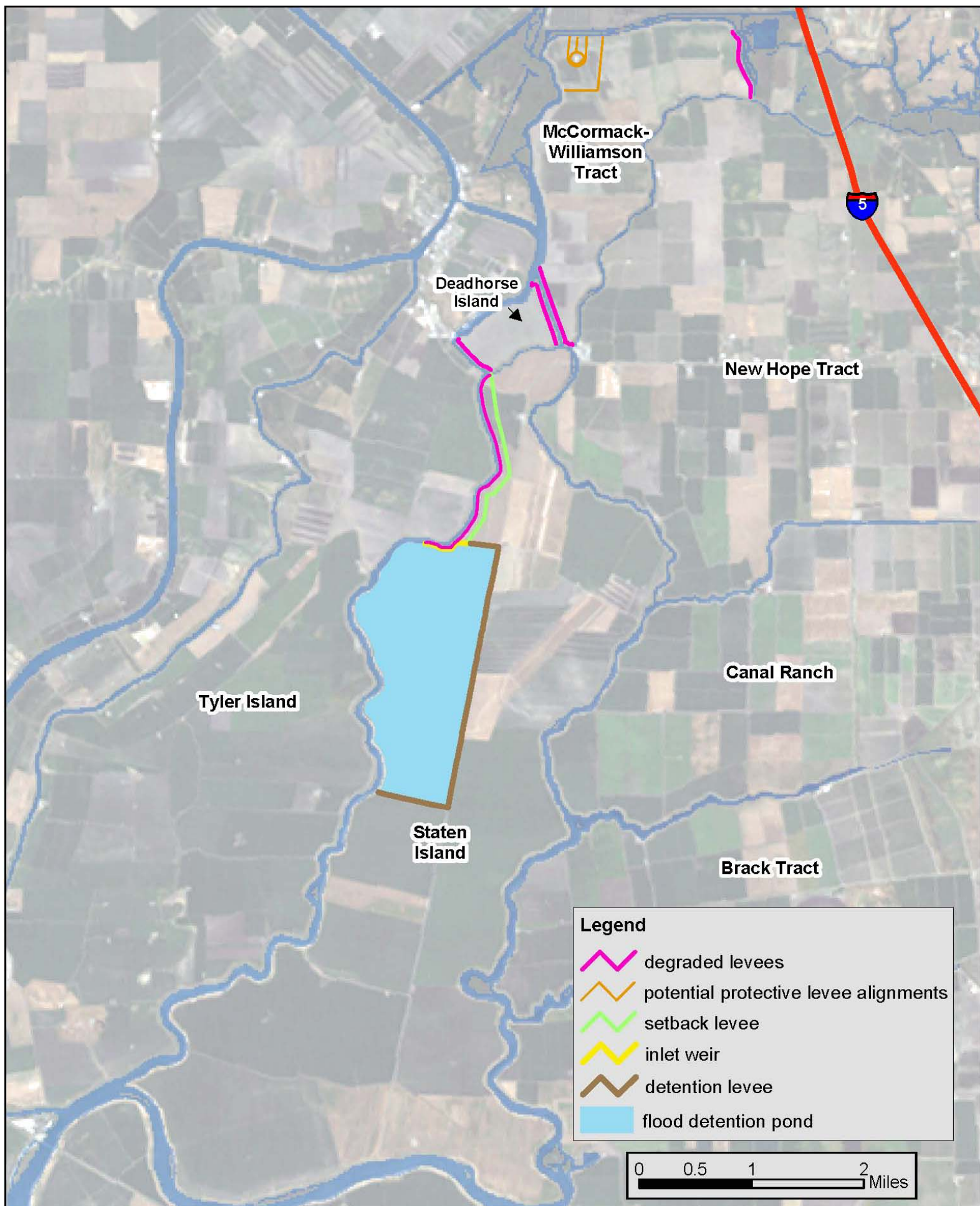


Figure 7: Flood Control Option 2 – West Staten Island Detention

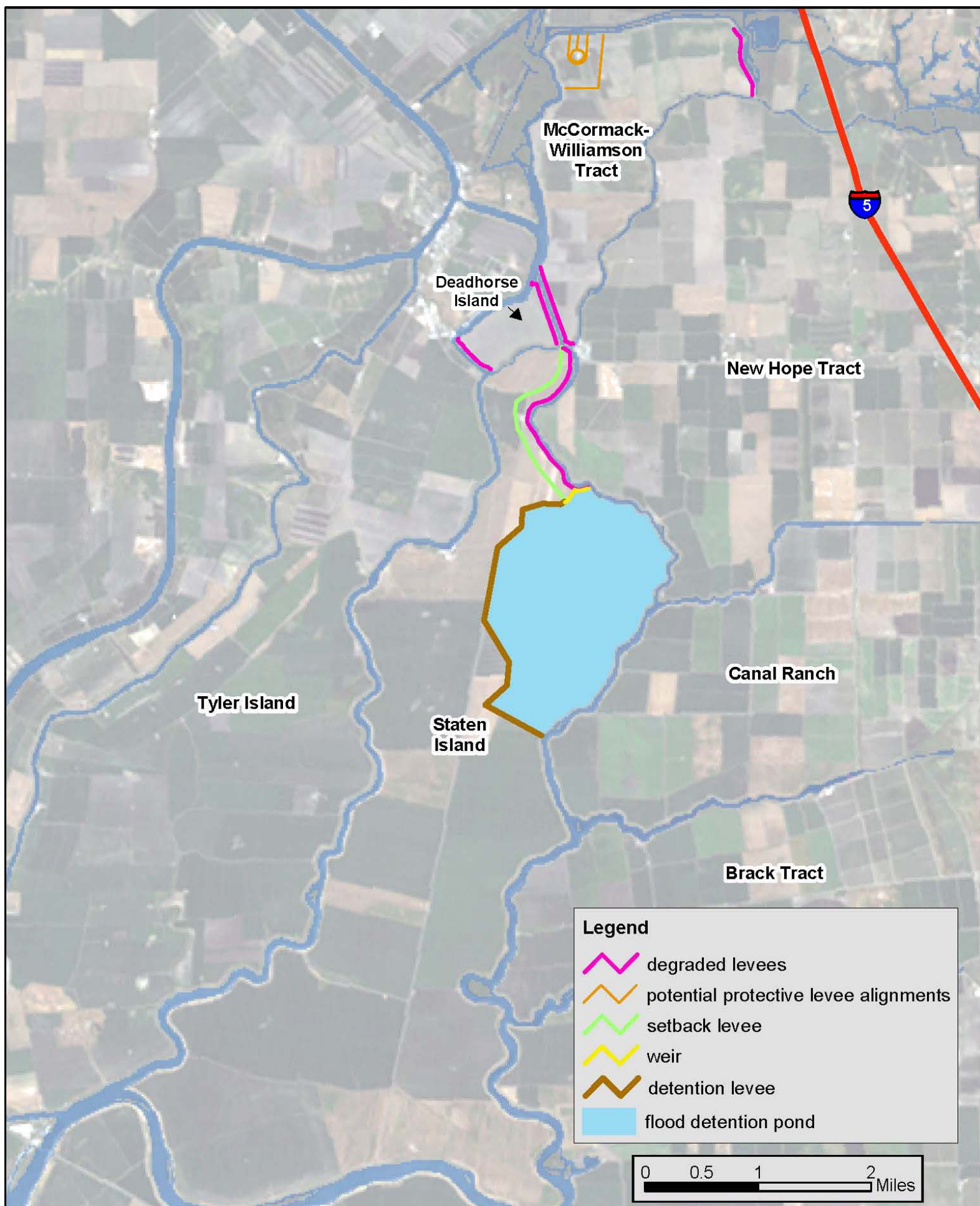


Figure 8: Flood Control Option 3 – East Staten Island Detention

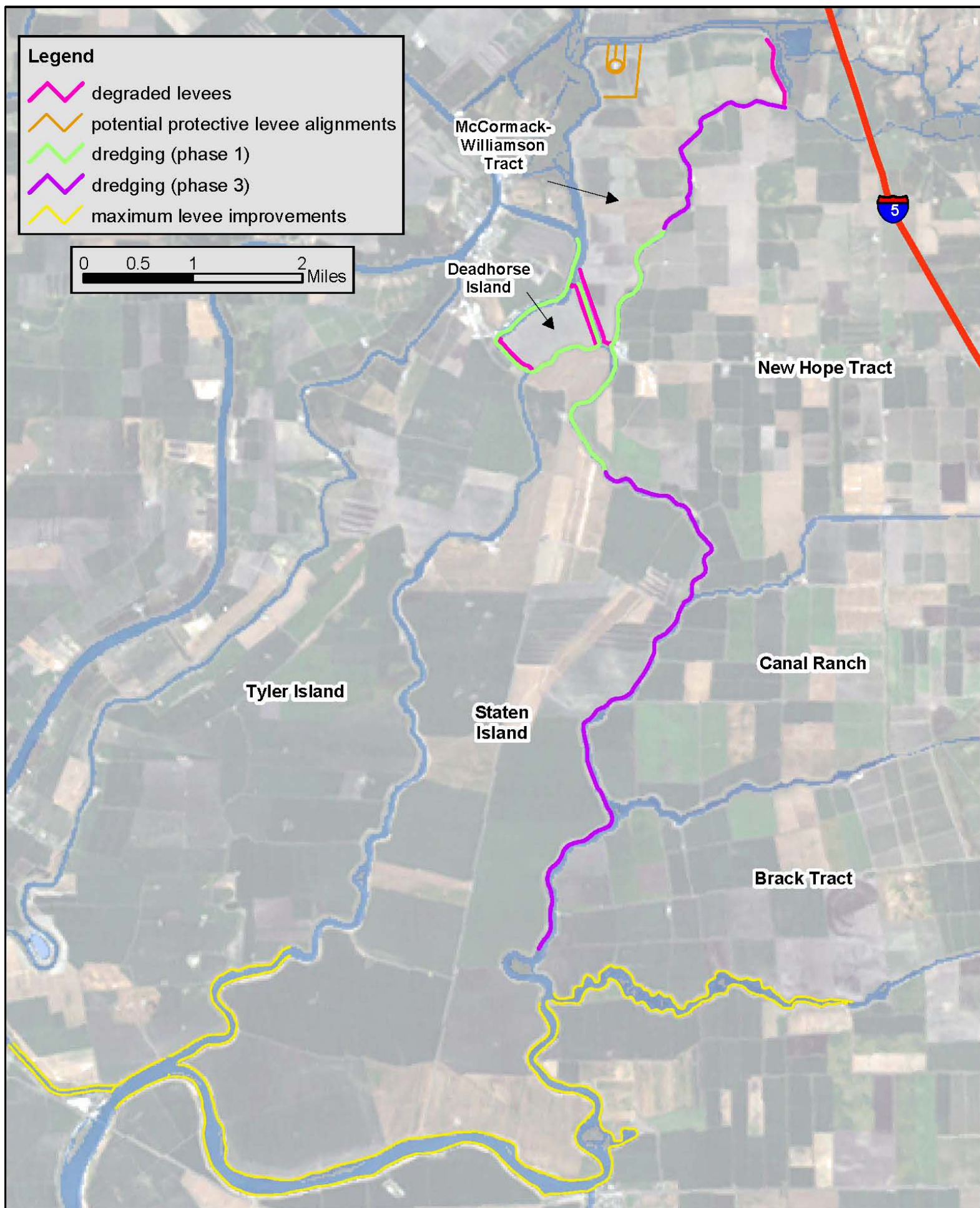


Figure 9: Flood Control Option 4 – Dredging and Levee Raising

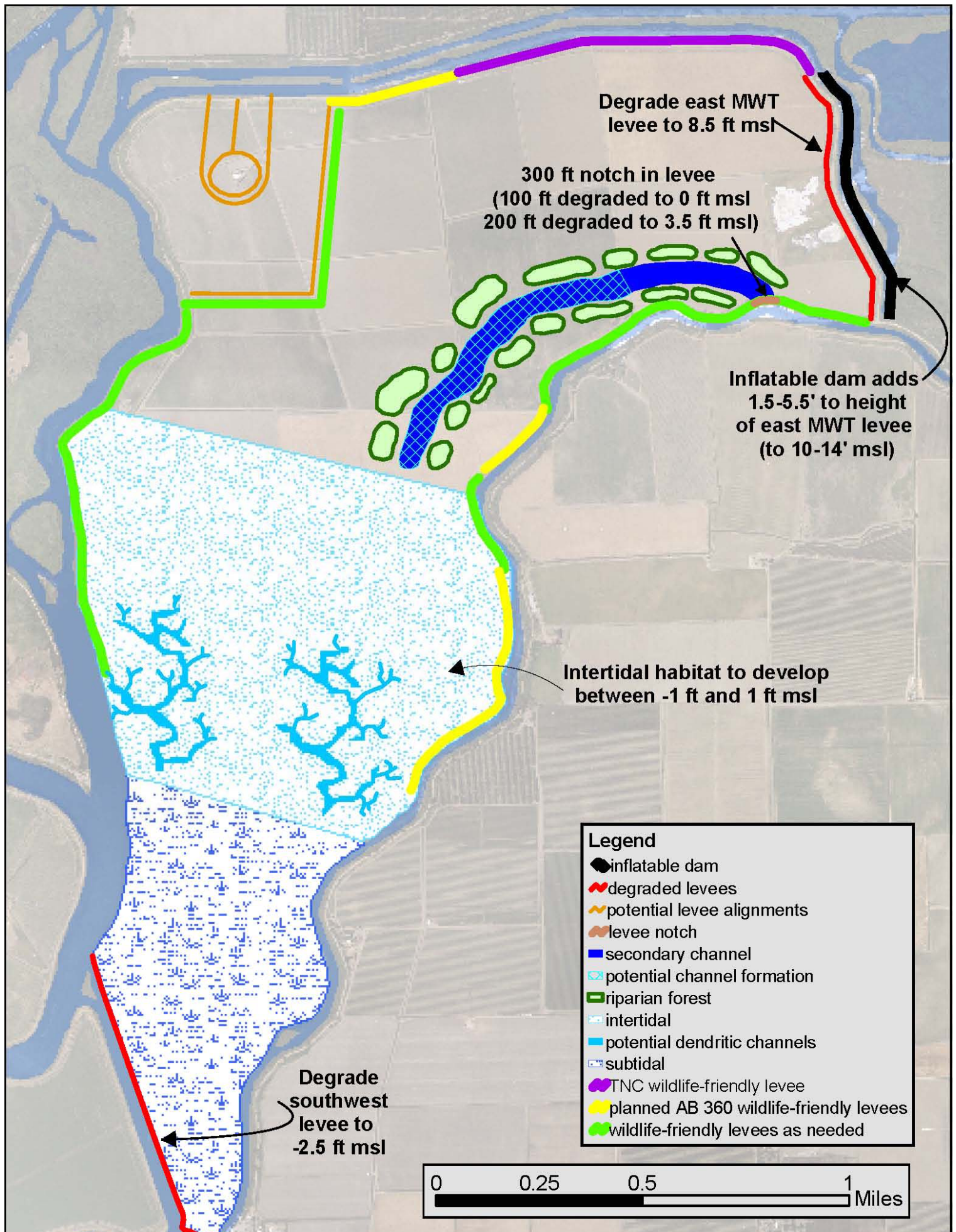


Figure 10: Ecosystem Restoration Option 1 – Fluvial Maximum (Minimum Control)

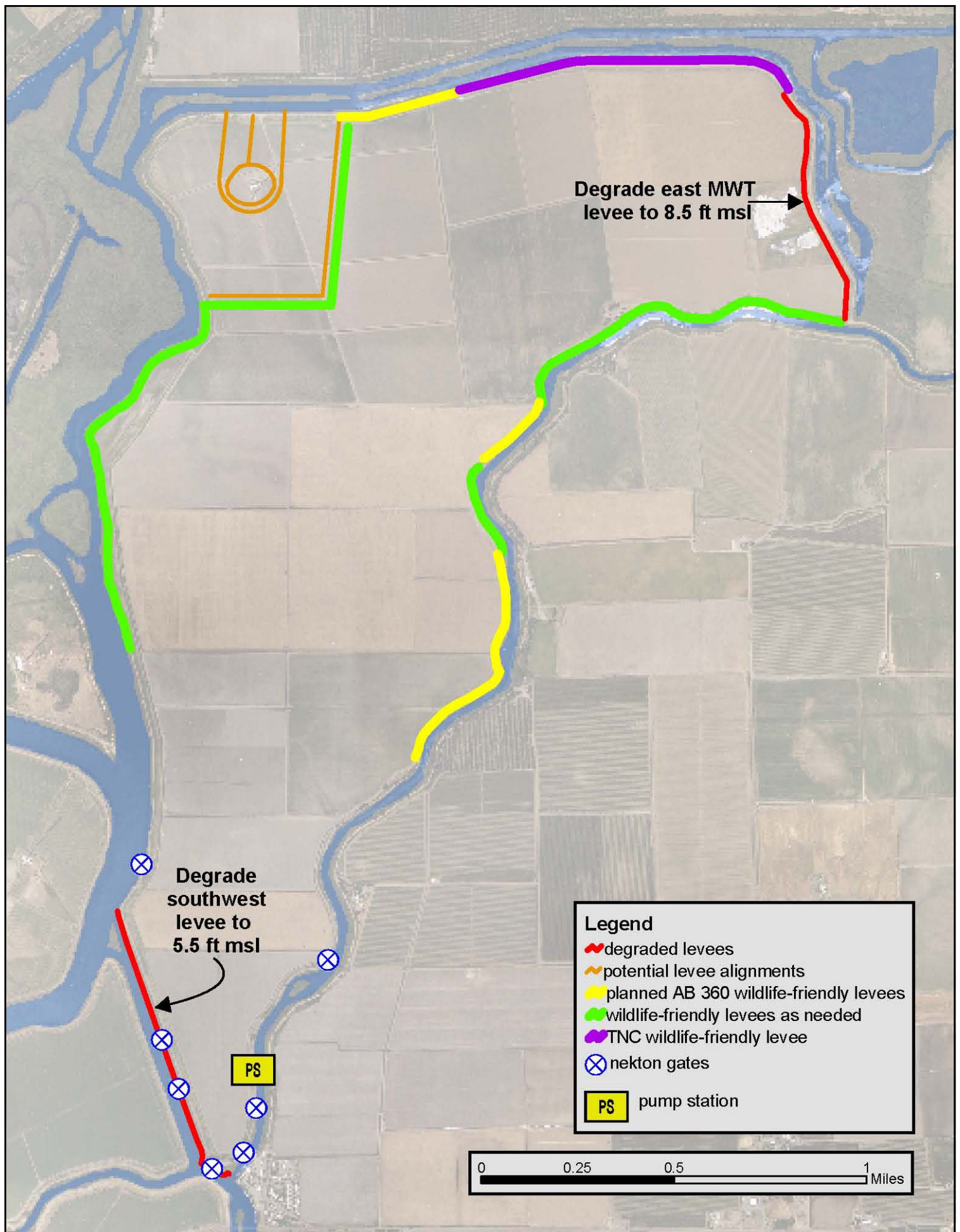


Figure 11: Ecosystem Restoration Option 2 – Fish Ecological Maximum (Maximum Control)

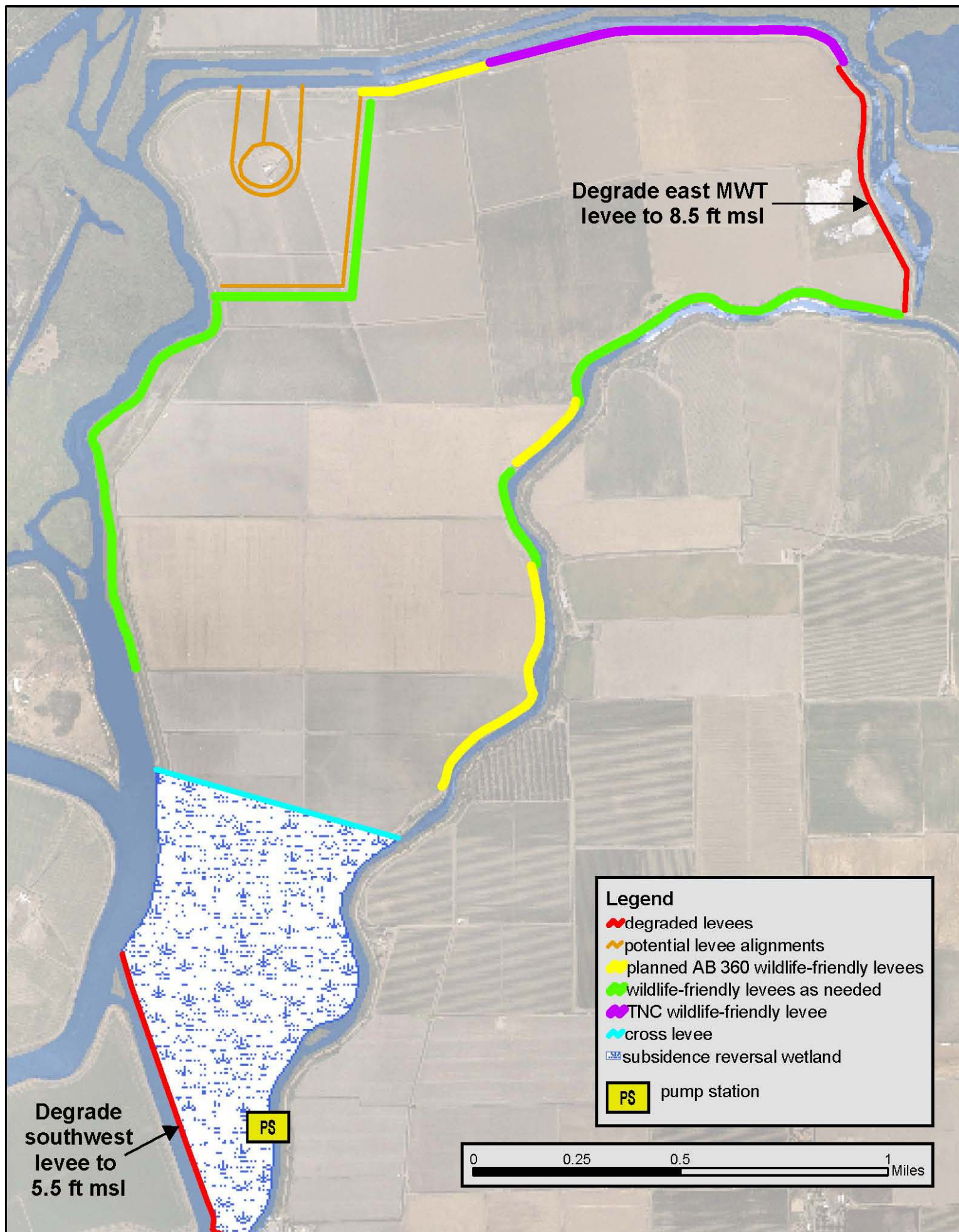


Figure 12: Ecosystem Restoration Option 3 – Hybrid Floodplain/Subsidence Reversal

Appendix A
Dredge Information

Appendix A1: Summary

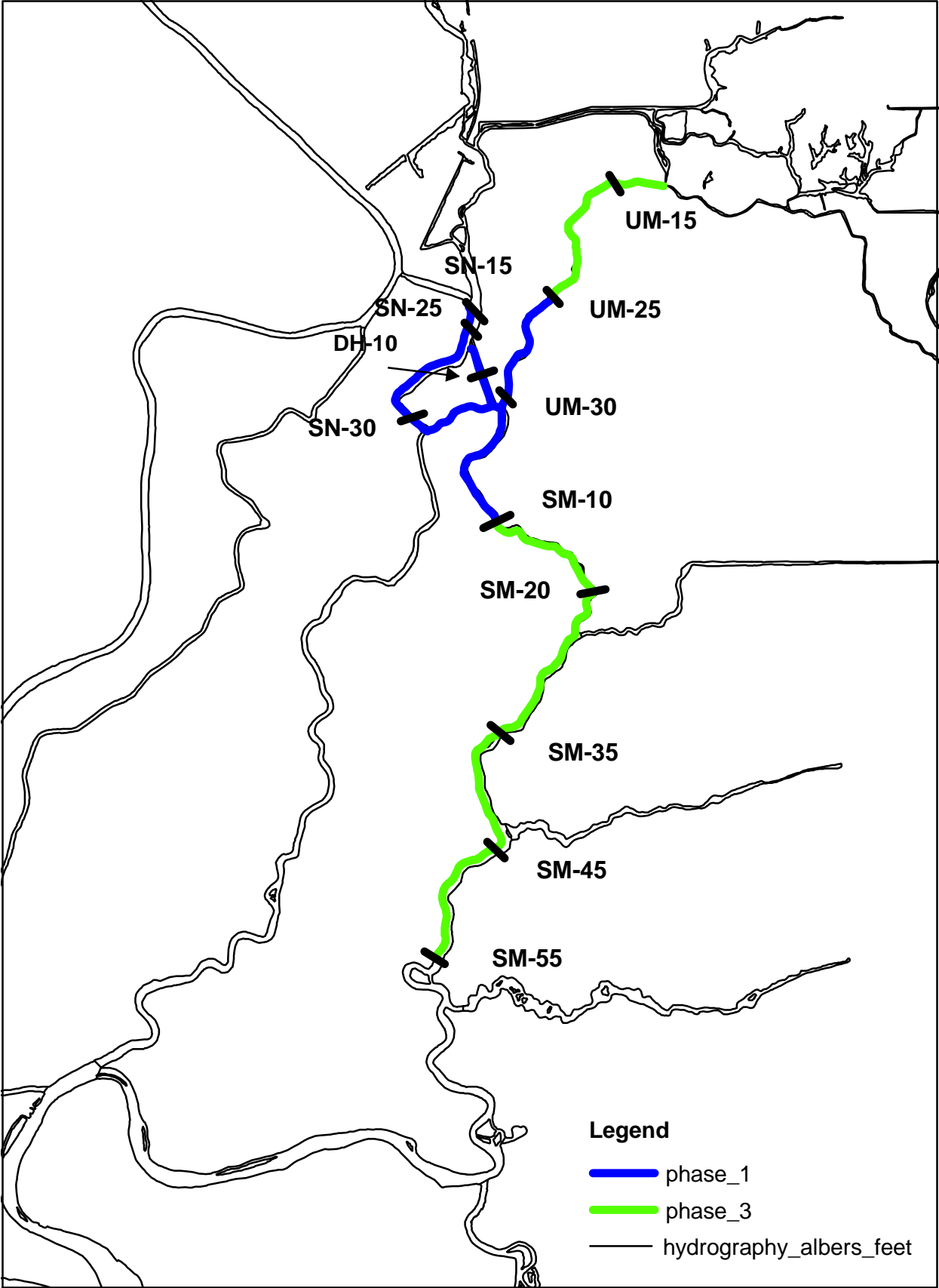
This appendix details the rationale for including dredging as a component of alternative 1D, 2D, 3D and 4 and methodology for calculating rough dredge quantity estimates for the alternatives. The maximum dredging bounds and quantities are the same for all alternatives where dredging applies, and the component is to increase channel capacity in locations where there is insufficient capacity. The dredged material is to be used for levee construction and ecosystem restoration. It is estimated between 5 and 9 million cubic yards of material could be dredged, within the project area bounds shown in Appendix A2.

Background on the North and South Fork Mokelumne Rivers will explain the rationale of incorporating a dredging component into each alternative. The 100 year event requires 90,000 cfs capacity in the North and South Fork combined. The current combined channel capacity is approximately 40,000 cfs and the flow split is 2/3 North Fork and 1/3 South Fork. Sediment deposition occurs on the South Fork channel, which decreases channel capacity. A decrease in channel capacity alters the natural flow split between the North and South Fork, causing scour on the North Fork from increased velocities. The North Delta Scour Monitoring Report indicates that the North Fork channels increased by 5%-47%, on average 17% within 6 years, whereas areas of the mainstem Mokelumne, South Fork and Snodgrass Slough have experienced sedimentation between 1994-2000.

Assumptions and guidelines specified in the 1990 EIR/EIS were considered in these estimates. Cross sectional areas along Snodgrass Slough and both the North and South Fork Mokelumne River greater than 8000 ft² were not considered for dredging. A cross sectional area of 20,000 ft² or more along the lower Mokelumne River was also not considered for dredging. Dredging is not to be done past 20 ft below mean sea level, and existing channel slopes are to be maintained where possible. These estimates do not maintain existing channel slopes in all dredge locations and will need to be refined.

The most recent data available was used to calculate areas within the project to be dredged (Refer to Appendix A2 for Dredge locations). The North Delta Scour Monitoring Program monitors several channel cross sections in the North Delta project area frequently. Cross sections monitored in the 1998-2000 report that correspond to this project's dredge locations are used in this analysis to determine the amount of material to be dredged for the North Delta Flood Control and Ecosystem Restoration Project. A compilation of levee data from the CALFED Levee Rehabilitation Study is the source of information for the calculation of additional channel capacity. Levees on both banks of the channel were evaluated and the shorter (with respect to mean sea level) was selected for analysis. Using the given waterside slope of the shorter levee, and assuming one foot of freeboard, the additional area at each representative cross section was calculated. The combined values is taken to be the channel capacity, and considered for dredging. The channel segments to be dredged were obtained with ARC GIS software and the hydrography data set on the GIS server. Using the trace tool, the segments to be dredged were matched with the channel, so that a relatively accurate length is computed.

Appendix A2: Dredge Locations



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Appendix A3: Calculation of Areas to be Dredged

Sediment Station	Existing X-sectional Area (ft²)	Island of Levee - Height of Levee (side 1 - ft)	Island of Levee - Height of Levee (side 2 - ft)	Existing Min. Levee Height (ft)	Channel width at mean sea-level (ft)	Existing Waterside slope (x on 1)	Additional X-area due to Levee	Total X-area (ft²)	Action
NM-10	1234	Staten - 14.9	Dead Horse - 9	9.0	125	2	1032	2266	Dredge
NM-30	4741	Staten - 12.8	Tyler - 14.9	12.8	350	2	4200	8940	None
NM-40	4392	Staten - 12.0	Tyler - 14.1	12.0	330	2	3691	8083	None
NM-50	4778	Staten - 11.1	Tyler - 13.4	11.1	330	2	3384	8162	None
NM-70	5969	Staten - 9.8	Tyler - 11.6	9.8	425	2	3779	9748	None
NM-75	6283	Staten - 9.8	Tyler - 11.1	9.8	335	2	2987	9270	None
NM-80	6914	Staten - 9.9	Tyler - 10.8	9.9	325	2	2932	9846	None
LM-50	8820	Bouldin - 9.6	Tyler - 9.6	9.6	850	2	7347	16167	Dredge
SM-10	1159	Staten - 14.6	New Hope - 14.7	14.6	210	2	2948	4107	Dredge
SM-20	1650	Staten - 12.9	New Hope - 12.4	12.4	175	2	2060	3710	Dredge
SM-35	2557	Staten - 10.8	Canal Ranch - 10.8	10.8	375	2	3723	6280	Dredge
SM-45	3844	Staten - 10	Brack Tract - 10	10.0	350	2	3191	7035	Dredge
SM-55	5246	Staten - 10	Brack Tract - 10	10.0	365	2	3326	8572	None
SN-10	2818	McCormack - 8	Not available	8.0	425	2	3000	5818	Dredge
SN-15	4271	McCormack - 8	Not available	8.0	575	2	4050	8320	None
SN-20	3975	McCormack - 8	Not available	8.0	430	2	3035	7009	Dredge
SN-25	3871	Dead Horse - 9	Not available	9.0	465	2	3752	7623	Dredge
SN-30	2876	Tyler - 16.1	Dead Horse - 9	9.0	225	2	1832	4708	Dredge
DH-10	1418	Dead Horse - 9	McCormack - 8	8.0	230	2	1635	3052	Dredge
UM-15	1347	McCormack - 8	New Hope - 19	8.0	125	2	900	2246	Dredge
UM-25	1200	McCormack - 8	New Hope - 16	8.0	145	2	1040	2239	Dredge
UM-30	1317	McCormack - 8	New Hope - 16	8.0	150	2	1075	2392	Dredge

Note: According to the 1990 North Delta EIR/EIS dredging is to be done to channels with cross-sectional areas less than 8000 ft² along the north and south forks of the Mokelumne River, 8000 ft² along Snodgrass Slough, and 20,000 ft² along the lower Mokelumne.

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Appendix A4: Dredge Quantities

Phase 1 Dredge Quantity

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mainstem & South Fork Mokelumne	UM-25, UM-30, SM-10	14646	5,087	2,784,741
Snodgrass Slough	SN-15, SN-25, SN-30, NM-10	13603	2,271	1,154,463
Deadhorse Cut	DH-10	3027	4,948	559,757

4,498,962

Phase 3 Dredge Quantity

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mokelumne River	UM-15, UM-25	10550	5,757	2,270,043
South Fork Mokelumne	SM-10, SM-35, SM-45, SM-55	31046	2,059	2,389,537

4,659,580

Maximum Dredge Bounds

Channel Section	Monitored X-Sections	Segment Length (ft)	Deficient X-Section (ft ²)	Dredge Quantity (yd ³)
Mainstem & South Fork Mokelumne	UM-25, UM-30, SM-10	14646	5,087	2,784,741
Snodgrass Slough	SN-15, SN-25, SN-30, NM-10	13603	2,271	1,154,463
Deadhorse Cut	DH-10	3027	4,948	559,757
Mokelumne River	UM-15, UM-25	10550	5,757	2,270,043
South Fork Mokelumne	SM-10, SM-35, SM-45, SM-55	31046	1,986	2,304,428

9,073,433